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Predicting the Onset of PTSD: An Analysis of Facial Expression of Emotion in Reaction to Aggressive Displays

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This paper provides a potential method to detect the early onset of, or the possibility of developing, PTSD through a series of tests relating to unconscious emotional facial expressions and physiological responses in conjunction with the resilience training currently offered in the Comprehensive Soldier Fitness (CSF) Program. Unconscious emotional responses, in the form of facial expressions, is proposed to be associated with a subconscious level of resilience, thus in turn predicting the risk an individual has of developing PTSD. Additionally, physiological measurements taken in conjunction with the facial expression analysis may further aid in predicting Soldiers who are at risk for developing PTSD. The proposed study will utilize facial expression analysis and physiological measures to assess the resiliency of Soldiers participating in the CSF program.

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ABSTRACT

This paper provides a potential method to detect the early onset of, or the possibility of developing, PTSD through a series of tests relating to unconscious emotional facial expressions and physiological responses in conjunction with the resilience training currently offered in the Comprehensive Soldier Fitness (CSF) Program. Unconscious emotional responses, in the form of facial expressions, is proposed to be associated with a subconscious level of resilience, thus in turn predicting the risk an individual has of developing PTSD. Additionally, physiological measurements taken in conjunction with the facial expression analysis may further aid in predicting Soldiers who are at risk for developing PTSD. The proposed study will utilize facial expression analysis and physiological measures to assess the resiliency of Soldiers participating in the CSF program.

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Introduction

Technological advancements in armor and medicine have allowed Soldiers to survive and physically recover from injuries that otherwise would have been fatal during previous wars (Warden, 2006). Nonetheless, the survival of such life threatening injuries and events has increased the number of casualties of a different kind; those which are cognitive in nature. Mental wounds developed during combat can be just as debilitating as physical wounds; however, unlike physical injuries, the wounds of cognitive casualties experiencing post traumatic stress disorder (PTSD) and/or other anxiety disorders are not readily visible. Accordingly, these psychological injuries, which can have devastating effects on a Soldier's thoughts and behaviors, go largely unnoticed.

Post traumatic stress disorder is a debilitating mental response to one or more extremely traumatic stressors that threatens an individual with death or serious injury, or threatens their physical integrity (American Psychiatric Association, 1994). Individuals who typically develop PTSD, such as combat veterans and victims of violent personal assaults, re-experience the traumatic event in various ways. This includes periodic and intrusive recollections and/or recurrent dreams during which the event is "relived." Physical symptoms can include "psychic numbing," hyper-vigilance, reduced emotional sensitivity, mood sensitivity, amnesia and diminished responsiveness to the outside world (Henline). The RAND Corporation, a nonprofit research organization, conducted a study beginning in April 2007 on the long- and short-term consequences of PTSD, major depression, and traumatic brain injuries of returning veterans who served in Iraq and Afghanistan. The study, which consisted of 1,965 service members and veterans, found that 14 percent of OIF and OEF veterans currently suffer from PTSD or major depression (Jaycox & Tanielian, 2008). Assuming this study is representative of the 1.64 million

Soldiers who have been deployed since October 2001, the RAND Corporation estimates that approximately 300,000 OIF and OEF veterans currently have PTSD (Jaycox & Tanielian, 2008).

Preemptively treating anxiety and depression would help the military reduce health and treatment costs, increase Soldier productivity, and promote retention levels by maintaining the psychological welfare of a healthy military force. Though emotional screening typically occurs during Soldier recruitment, many military personnel are still separated from service due to behavioral and mental health problems. Garb and Fiedler (2007) studied mental health issues in the US Air Force. The findings indicated that 15.8 percent of first-term enlistments between 1994 and 1999 were later separated for behavioral or mental health issues. To address this issue, the military must develop psychological screening tests that preemptively identify emotional traits which make Soldiers more susceptible to developing PTSD. The effective and early screening of such behaviors would allow the military to take preventative measures in treating anxiety and depression disorders, thus producing a more resilient military force. Resilience, as defined by Mastroianni et al. (2008), is the "interaction between individuals and their environment that leads to the achievement and maintenance of effective health and performance under stress." Therefore, promoting resilience is not only essential to Soldier retention, but is also critical to success at all levels of warfare, be it strategic, operational or tactical.

Research shows that certain situational appraisals, as well as feelings of certainty and control, are correlated with the development of PTSD. Based on a 2005 study conducted by Lerner, Gonzalez, Dahl & Taylor (2005), they note that there are coded facial expressions for fear, anger and disgust, which are all positively correlated with a person's feelings of certainty and control. Accordingly, we believe that it is possible to detect the onset of PTSD by monitoring a person's sensitivity to stress inducing images/emotions.

Unconscious Emotional Responses

Science and psychology share a common burden in attempting to define things that are difficult to define. For scientists, the question, “Why is the sky blue?” is a question more difficult than initially thought. Nevertheless, a definition and reason for this phenomenon is able to be defined by objective measures through scientific theories. For psychologists on the other hand, some of the questions are a more difficult to define. The question “What is an emotion?” and “How can we know if a person is experiencing one?” is more difficult to define and even more difficult to measure. Even so, that is the burden taken on by psychologists and is the basis for this proposed experiment designed to detect the early onset of PTSD through recognition of specific facial expressions of emotion in response to aggressive, violent, and gruesome audio and visual displays (Peck, 1987).

Dr. Paul Ekman is considered to be the leading expert on the psychology of emotion and the expression of that thereof; his work is extensively valuable in researching this topic. Dr. Ekman was and still is very protective of his research as he found early in his career that people were inquiring about his research for the wrong reasons. He feared that this “ability” would be abused and has since then been more careful and specific in his work (Ekman, 2009). This research proposal gives careful consideration and attention to these issues in order to respect the intent of his work.

In some of his early research, it was found that *every* person exhibited six main emotions through expression: *happiness*, *surprise*, *fear*, *sadness*, *anger*, and *disgust* combined with *contempt* (Ekman, Are there basic emotions?, 1992). These six emotions act as the RGB scale for further analysis on this subject. Though more emotions have come about, such as *shame* and *interest* among many others, these six are the primary base emotions for facial expression

analysis. Pairing this research with his extensive work with deception and lying, Dr. Ekman has been able to develop and defend explanations supporting the validity of facial expression of emotion.

The involuntary facial expressions of emotion, or unconscious emotional response, are the product of evolution. Many human expressions are the same as those seen on the faces of other primates. Some of the facial expressions of emotion, at least those indicating the emotions mentioned before, are universal, the same for all people regardless of age, sex, race, or culture (Ekman, 2009). Charles Darwin came to the same conclusion in his work over 135 years ago. His literature indicated that facial expressions of emotion include universal, reliable markers that are part of a coherent package of emotional responses judged as discrete categories with interpersonal and social regulatory functions (Lewis, Haviland-Jones, & Barrett, 2008). This is key in understanding the value of emotional responses in the shape of expression. Though there are other forms of emotional expression, such as gaze, head position, posture, touch, or proximity, the focus here is on the face (Lewis, Haviland-Jones, & Barrett, 2008).

Facial expressions are systemic with those actions made by the rest of the body thus giving it social regulatory function and value for the later described experiment. In other words, each reaction or expression has a purpose, it is not random. Facial expressions that accompany actual emotional experiences are more reliable signals; they act as commitment devices to likely courses of action that are momentarily beyond the individual's volitional control (Lewis, Haviland-Jones, & Barrett, 2008). For instance, we express *anger* by furrowing the brow (corrugator muscle) and tightening the red margins of the lips (produced by the orbicularis oris and pars medialis, evident only in anger) with teeth displayed, because these actions are part of an attack response (Ekman, Are there basic emotions?, 1992); we express *disgust* with an open

mouth, nose wrinkle, and tongue protrusion as part of a vomiting response (Lewis, Haviland-Jones, & Barrett, 2008). Similarly, it is hard for someone not to tuck their chin in and pull back when they say, "What is that smell" with an expression of *disgust* because they want to get away from whatever is disgusting. In this way, all humans create equal expressions in similar circumstances, not considering the ever-present outliers. If something hurts, a person will show *pain*, if something is scary, a person will show *fear*. All humans around the world, regardless of race or culture, have the same facial anatomy and as such, emotional expressions (Lewis, Haviland-Jones, & Barrett, 2008). The questions now become: "Is this information testable?" "Can we measure this in all people?" "Is this a reliable method to test and detect the early onset, or possibility of developing PTSD?" The latter part of this paper will address those questions.

Considering that the research performed on unconscious facial expression of emotion is relatively new, it is necessary to incorporate additional measures in developing an assessment strategy to ensure validity is not compromised. As such, the proposed assessment will include physiological measures to substantiate those claims made by facial recognition theory.

Physiological Responses

Just as people interpret stress differently, the biological responses to stress are also unique. The autonomic, neuroendocrine, and immune systems are interrelated biological stress mediators which respond differently to challenges (Lukey & Tepe, 2008). In essence, these mediators interact in a nonlinear network to control allostasis and allostatic load. The most immediate biological reaction to stress is the "fight-or-flight" response. This reaction affects the immune system, energy mobilization, and memory enhancement to prepare the body to either confront the stressor or run from it (McEwen, 2006). The prefrontal cortex and limbic system,

composed of the hypothalamus, amygdala, and hippocampus, control these biochemical mechanisms which physically prepare the body for this response (Lukey & Tepe, 2008).

Located in the brain between the brain stem and the cortex, the limbic system regulates survival behaviors such as the instinctive "fight-or-flight" defenses. Accordingly, it mediates arousal, and therefore hyperarousal, which is characteristic of PTSD patients (Rothschild, 1998). Due to its control over such behaviors, the limbic system shares a relationship with the autonomic nervous system (ANS), which regulates certain physiological mechanisms such as heart rate and the circulatory system, pupil dilation and other internal organs. Arousal of the sympathetic nervous system (SNS), a branch of the ANS, results in increased heart and respiratory rates, changes in skin conductance and pupil dilation as well as raised blood pressure (Rothschild, 1998).

A study conducted by Van der Kolk (1994) found that people who suffer from PTSD have increased physiological arousal in response to sounds, images, and thoughts related to their traumatic event. Such arousal included significant increases in heart rate, skin conductance, and blood pressure. The physiological responses to these stimuli demonstrate that PTSD patients are more sensitive to SNS activation when they perceive stimuli as threatening.

Further studies conducted by Metzger and colleagues (1999) also found physiological differences in patients with PTSD. The study was conducted on women with PTSD regarding their reactions to startling tones. They discovered that women with PTSD had different physiological responses to the startling tones than women not diagnosed with PTSD. More specifically, PTSD patients had a greater accelerated heart rate response and slower habituation of skin conduction responses to startling tones. Carson and colleagues (2007) confirmed these results with a similar study conducted on nurse veterans of the Vietnam War. These women

developed PSTD after repeated exposure to patient deaths, injuries, and suffering. The study found that PTSD is associated with increases in heart rate in response to loud, startling tones.

The results of these studies show a positive correlation between PTSD and exaggerated startle response. Nonetheless, it is difficult to ascertain whether the documented physiological and psychological differences are the result of developing PTSD or if these differences existed before the onset of PTSD. Morgan et al. (2000) explains that if the latter is true, then it may be possible to use these risk factors to screen for people who are potentially susceptible to developing PTSD. For instance, individuals who are naturally more sensitive to certain stimuli may also find it more difficult to cope with certain traumatic events. Accordingly, Dr. Morgan and his team began performing prospective, rather than retrospective, studies on military personnel going through survival training at FT Bragg. Salivary cortisol data from 109 Soldiers during designated stressful events revealed that cortisol levels significantly increased during captivity and was greatest after interrogations. In contrast, testosterone levels decreased within twelve hours of captivity. The researchers concluded that the degree of neuroendocrine changes among Soldiers may reveal how the Soldier will respond to certain traumatic events and, in essence, whether or not a Soldier is susceptible to developing PTSD.

Performing additional research at FT Bragg, Morgan et al. (2000) also measured the concentration of the neurochemical Neuropeptide-Y (NPY) in 70 Soldiers going through survival training. NPY is produced by the amygdala and helps to relieve anxiety and reduce the negative effects of stress (Thorsell, 2008). The researchers discovered that the Green Beret trainees produced significantly more NPY than the Army Rangers and Marines going through the same training. Furthermore, NPY levels of the Green Beret trainees returned to normal baseline levels 24 hours after the training exercise, while the Rangers' and Marines' NPY levels were

significantly depleted (Morgan et al., 2000). They also found a negative relationship between performance scores and NPY levels in that the less NPY a Soldier produced, the more likely the Soldier dissociated and performed poorly during the exercise. From these results, Morgan et al. (2000) concluded that some physiological factors precede PTSD development and that screening methods can be developed to identify individuals who may be more prone to developing PTSD symptoms.

Though performing this physiological analysis on every Soldier would be time consuming and costly, it is still useful to our experimental purpose. As previously cited, the basic physiological measurements, such as heart rate, blood pressure, and skin conductance, are good indicators of stress reactions that can confirm the results of emotional facial responses. Once these analyses flag a Soldier as being sensitive to developing PTSD symptoms, further salivary and blood tests can be conducted to determine whether or not that Soldier is indeed biologically predisposed to developing PTSD.

Proposed Study Method

Participants

Soldiers from eight Brigade Combat Teams (BCTs) that are participating in the CSF program will be recruited for the study. A total of 100 Soldiers per BCT will be included.

Apparatus and Procedure

The proposed experiment, for assessing the effectiveness of training given through the CSF program, in conjunction with possibly predicting the onset of or possibility of developing PTSD, relies heavily on the work of Dr. Ekman and his colleagues. The following paragraph will first outline the basis of the experiment and then elaborate in more detail on what exactly these measures entail.

The experiment would consist of a subject viewing an aggressively gruesome video that progressively got more intense as time increased. The purpose of increasing the intensity would be to measure the reaction of a person beyond his or her comfort zone. If the intensity remained the same throughout, a person who was resilient to its features would provide no data or feedback to the observer. Furthermore, while the participant is watching the aggressive video, a video camera (or a physical observer) is watching him or her to assess the expressions of emotion shown on the face, labeling them as *happiness*, *sadness*, *contempt*, *anger*, *fear*, *surprise*, or *disgust* (defined in Appendix A). If feasible, a video camera would be used in order to review the footage for later use or for instructional purposes. Simultaneous with the observer assessing the participant watching the video, the participant is connected to a "truth detector" machine, a phrase stolen from its contrary apparatus, the "lie detector". This "truth detector" would include measurements for skin conductance, measured in microSiemens, heart rate, measured in beats per minute, and blood pressure, measured in millimeters of mercury. The purpose of these extra measurements is to validate the recognition of facial expression of emotion. These additional measures should, in theory, support the decision of the observer.

In considering the use of an experiment that would rely on the recognition of facial expressions of emotion, practical concerns raised a very fundamental question about human communication: "Can people, even when they are very upset, control the messages they give off, or will their nonverbal behavior leak what is considered by their words (Ekman, 2009)?" First, it is important to understand that there are different levels in which emotional expressions can be defined. Take *anger* for example. There are six different criteria that could change the significance of the expression: the intensity, from annoyance to rage; how controlled it is, from explosive to fuming, how long it takes to begin, how long it takes to end, temperature, and

genuineness (Ekman, 2009). This is the criteria that will be used to assess each individual. It would be unrealistic to a certain extent, to expect an individual, hardened combat veteran or not, to sit through a gruesome video and not show any signs of *disgust*, *sadness*, or *surprise*. In fact, if *happiness* is the only emotion demonstrated, it would be considered a problem and the participant would be flagged. So, it is necessary to keep a close eye on the extent and how quickly these emotions come and go to analyze the resilience of each Soldier. For instance, if a Soldier expresses the emotion of *fear* for an extensive amount of time when he or she sees the graphic material, it would be of concern. A "normal" time span of an emotion, which has yet to be defined, will act as the basis for discretion and any deviance from that baseline will be assessed accordingly. The lack of data to form an initial baseline metric against which the outcomes may be assessed is a limitation of the proposed study.

The proposed study was based on a similar experiment in which a group of participants sat in a room and watched a very unsettling film, which showed bloody surgical scenes. Participants then had to conceal their true feelings of *distress*, *pain*, and *revulsion* and convince an interviewer, who could not see the film, that they were enjoying a film of beautiful flowers (Ekman, 2009). The study results indicated that the participants were not able to suppress their true emotions in their facial expressions. Is it true that there is no way humans can cover-up their emotions? This is an issue that needs to be scrutinized carefully.

The first years of life, children are taught to conceal their true emotions with statements like, "Wipe that smirk off your face," "Smile when grandma gives you a hug even though you don't like it," "Don't look so bored," or, "If you're not happy, fake it!" Knowing this, it is not surprising that in the military, it is encouraged to conceal certain emotions to conceal weakness with phrases such as "Soldiers don't cry," "false motivation," and "rub some dirt in it, drink

water, and move out" (Ekman, 2009). The concern is that people are going to mask their emotions, a valid concern, seeing that most gestures people aren't proud of are quickly covered by a smile or something similar. The research done to assess this concern looks to the human brain for the answers. There, it was found that the parts of the brain for voluntary and involuntary expressions are different. For example, a person who has brain damage that affects the ability to smile when asked to do so (voluntary), will produce a smile when hearing a joke or watching something funny (involuntary) (Ekman, 2009). Now with this new information, it can be understood that the true, felt expressions of emotion occur because facial actions can be produced involuntarily, without thought or intention. People are able to conceal them or cover them up with other expression, though usually done in an awkward, non-natural manner (the "awkward smile" which signals someone being uncomfortable) (Ekman, 2009). Now, perfectly innocent behavior, such as a smile, seems suspicious if out of place or displayed in a non-genuine manner.

Further evaluation on this matter, the possibility of a person faking an emotion, brought about more interesting information. The muscle movements required for most complex emotions (listed shortly) are very difficult to mimic/fake. For instance, the muscle movements that occur with *fear*, *worry*, *apprehension*, or *terror*, those that would be initial identifiers of PTSD, are extremely difficult to make deliberately by those who want an excuse to get out of training. More than ninety percent of people tested in attempting to make these expressions voluntarily were not able to produce the required combination of actions simultaneously deliberately (Ekman, 2009). To better explain this, as a reader, attempt to do the following: pull the eyebrows down and together in what Darwin calls the "muscle of difficulty", or the scientifically named corrugator muscle. This is not seemingly difficult. Now, give the expression of someone about to lift

something heavy or trying to solve a complex mathematical expression. The point here is that some of these expressions are difficult, though not impossible, to make by voluntarily moving the required muscles. On the other hand, it is fairly easy to make the expression by putting the mind in a mental state to mimic the required expression. Another example would be to make the face following the expression, “Oh, look at the poor little kitty,” then making the expression of, “And who do you think you are?” These facial expressions of emotion are very similar in look, though completely different. To attempt to fake these emotions in the moment of a different emotion would very difficult if not impossible, especially for the average, untrained individual.

The only thing missing from this assessment proposal to make it possible is trained experts. How long does it take for a person to become a trained expert? Dr. Ekman claims that with about one hour’s practice, most people can learn to see such very brief expressions; anyone can learn this skill (Ekman, 2009). One of the contributors of this paper, Cadet Landon Cheben, completed the F.A.C.E. training provided by Ekman on his website, receiving a certificate of the rank of expert, in only 90 minutes. The one major concern is possible experimenter bias in assessing Soldiers. Some people are able to “get away with” covering up their emotions because they know that the person assessing them wants to be misled. When a mom asks her son if everything is ok, she wants to hear “yes”, so when it is said, even as a lie, it goes undetected. Thus the researchers need to ensure that the person doing the analysis is a neutral person, not the unit commander or someone who is in the same unit, as they would not want to admit that the Soldiers in their unit are not strong (Ekman, 2009).

All things considered, the actual proposed assessment is simple. While an individual is watching the gruesome video, an expert would assess the resilience of the person based on the expressions made using the criteria listed before: the intensity, from annoyance to rage; how

controlled it is, from explosive to fuming, how long it takes to begin, how long it takes to end, temperature, and genuineness. What would label an individual as one who is not resilient, or one who is not responsive to the training, would be someone who is not in line with the average measurements obtained across participants. In other words, if a Soldier is acting significantly different from the rest of his or her peers in the same situation, he or she would be flagged. Unfortunately, this "normal" baseline does not currently exist, but can actually be created within the eight brigades in a relatively short period of time. The physiological measures, to include galvanic skin response, heart rate and blood pressure, would be taken in conjunction with the facial assessment. All of these measures may be taken using portable, relatively inexpensive devices that may be worn on the wrist. An alternative method includes the use of wireless technology; however, this may not be a feasible alternative based on the study location, potentially prohibitive costs, and training required.

Conclusion

In conclusion, the theories proposed for this assessment are new and continue to evolve. Nevertheless, when used in parallel with physiological measures, the emotional assessment used is able to be validated against objective results. Although the CSF program is the forerunner in the fight against PTSD and other anxiety disorders, it needs methods to assess vulnerability or resilience before a Soldier before is placed in a stressful combat situation. In the same manner physical trainers must assess and treat brain injuries before allowing rugby players to compete in a match, the military must also identify those at risk to developing cognitive injuries that could comprise mission and life.

Annotated References

American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders (4th ed.)*. Washington, DC.

This citation of DSM IV explains the characteristics of PTSD and how PTSD patients typically develop the disorder.

Carson et al., (2007). Physiologic reactivity to startling tones in female Vietnam nurse veterans with PTSD. *Journal of Traumatic Stress*, 20(5), 657-666.

They compared the physiological responses of PTSD and non-PTSD subjects to startling stimuli. They found that PTSD patients had more extreme increases in heart in response to the startling stimuli.

Ekman, P. (1992). Are there basic emotions? *Psychological Review, 99* (3), 550-553.

Dr. Ekman writes this article in a response to another party who criticizes the claims made of basic emotions and the ability to identify them.

Ekman, P. (2009). *Telling Lies: Clues to Deceit in the Marketplace, Politics, and Marriage*. New York: W. W. Norton & Company.

This book was helpful in understanding what the face is able to do in attempting to mask or replace a natural expression with a fake one. This was critical to understand as a common critique of the proposed assessment strategy would be if someone could beat the assessment by faking an emotion. This books explains how this is very difficult to do.

Garb, H.N., & Cigrang, J. (2008). Psychological screening: Predicting resilience to stress. In B. Lukey, & V. Tepe. *Biobehavioral Resilience to Stress*. Boca Raton: CRC Press, 4.

This text discusses many aspects of PTSD, to include biological and environmental causes, symptoms and treatment. Furthermore, this text also discusses resilience and hardiness and how these traits help a Soldier deal with anxiety and depression.

Henline, L. *Post Traumatic stress disorder: The biological aspects*. Arizona School of Professional Psychology. Retrieved from http://www.users.uswest.net/~abnormal/PTSD.htm.

This resource discusses the physical symptoms associated with PTSD.

Jaycox, L. & Tanielian, T. (2008). Invisible wounds of war: Psychological and cognitive injuries, their consequences, and services to assist recovery. Center for Military Health Policy Research: RAND Corporation.

These researchers conducted a study that found that 14 percent of 1,965 current OEF and OIF veterans sampled currently have PTSD. If this statistic remains true, then roughly 300,000 veterans are likely to have PTSD.

Lerner, J. S., Gonzalez, R. M., Dahl, R. E., Hariri, A. R. & Taylor, S. E. (2005). Facial expressions of emotion reveal neuroendocrine and cardiovascular stress responses. *Biological Psychiatry, 58*, 743-750.

These researchers found that a person's feelings of certainty and control are correlated with their emotional responses of fear, anger and disgust. These three emotional responses are seven of the primary emotional facial expressions that can be identified as cited by Dr. Ekman. We also know that these three emotional responses are related to a person's feelings of stress and anxiety.

Lewis, M., Haviland-Jones, J. M., & Barrett, L. F. (2008). *Handbook of Emotions*. New York: The Guilford Press.

This book was written for actors in order for them to become more fluent in producing facial expressions of emotion. Additionally, through reading the book and trying the examples, the difficulty in producing expressions of emotion voluntarily was supported.

Lukey, B., & Tepe, V. (2008). *Biobehavioral Resilience to Stress*. Boca Raton: CRC Press, 92-95.

This text discusses many aspects of PTSD, to include biological and environmental causes, symptoms and treatment. Furthermore, this text also discusses resilience and hardiness and how these traits help a Soldier deal with anxiety and depression.

Mastroianni, G., Mabry, T.R., Benedek, D.M., & Ursano, R.J. (2008). The stresses of modern war. In B. Lukey, & V. Tepe. *Biobehavioral Resilience to Stress*. Boca Raton: CRC Press, 43.

This text discusses many aspects of PTSD, to include biological and environmental causes, symptoms and treatment. Furthermore, this text also discusses resilience and hardiness and how these traits help a Soldier deal with anxiety and depression.

McEwen, B.S. (2006). Protective and damaging effects of stress mediators: central role of the brain. *Dialogue in Clinical Neuroscience*, *8* (4), 367-381.

This author discusses the biological processes that take place during the "fight-or-flight" response.

Metzger et al. (1999). Physiologic reactivity to startling tones in women with posttraumatic stress disorder. *Journal of Abnormal Psychology*, *108*(2), 347-352.

These authors discovered that PTSD patients, in response to startling tones, showed increased physiological responses such as heart rate and skin conductance in comparison to the control group without PTSD.

Morgan et al., (2000). Hormone profiles in humans experiencing military survival training, *Biological Psychiatry*, *47*(10), 891-901.

Dr. Morgan and colleagues discovered that cortisol levels significantly increase following stressful events while testosterone levels are considerably reduced.

Morgan et al. (2000). Plasma neuropeptide-Y concentrations in humans exposed to military survival training, *Biological Psychiatry*, 47(10), 902-909.

Dr. Morgan and colleagues discovered that Soldiers, such as Green Berets, who produce higher concentrations of NPY are typically more resilient to stress and stress inducing stimuli. Accordingly, they believe physiological factors precede PTSD development and that screening methods can be developed to identify individuals who may be more prone to developing PTSD symptoms.

Peck, S. R. (1987). *Atlas of Facial Expression: An Account of Facial Expression for Artists, Actors, and Writers*. New York: Oxford University Press.

This book is similar to the other book written for actors. It provided a better understanding of the physical expression of emotion.

Rothschild, B. (1998). Post-traumatic stress disorder: Identification and diagnosis. *The Swiss Journal of Social Work.* Retrieved from http://www.ptsdsupport.net/ptsd_details.html

Rothschild discusses the role the limbic system has on arousal and hyperarousal, which are traits of patients with PTSD. This author also elaborates on the role that the autonomic and sympathetic nervous systems play in the physiological responses to stressful stimuli.

Thorsell, A. (2008). Central neuropeptide Y in anxiety- and stress-related behavior in ethanol intake. *Annals of the New York Academy of Sciences*, 1148, 136-140.

This resource describes the production of the neurochemical NPY and its role in relieving anxiety and reducing the negative effects of stress.

Warden, D. (2006). Military TBI during the Iraq and Afghanistan wars. *Journal of Head Trauma Rehabilitation, 21*(5), 398–402.

This citation explains how technology has increased the survival rate of Soldiers who, in previous wars, may have suffered from a fatal injury.

Van der Kolk, B. (1994). The body keeps the score: Memory and the evolving psychobiology of posttraumatic stress. *Harvard Review of Psychiatry, 1*(5), 253-265.

The author found that PTSD patients have increased physiological arousal in response to sounds, images, and thoughts related to their traumatic event. Such arousal includes significant increases in heart rate, skin conductance, and blood pressure.

Appendix A – Definition of Facial Expression of Emotion

Anger:

- Eye brows are pulled down and together
- The upper eyelid is raised appearing to glare
- The lower eye lid is also tensed
- The lips are pressed tightly, or open with tensed lips

Disgust:

- Two different versions:
    1. Eyes pulled down more
    2. Strong wrinkles around sides and bridge on nose
- Upper lip is raised and squared shaped
- Only one muscle is needed to signal disgust clearly (levator labii superioris, alquae nasi, which raises the nares, pulls up the infraorbital triangle, and wrinkles the sides of the nose) and that muscle action does not occur systematically in any other emotion.

Anger and Disgust:

- Anger and disgust are usually confused. The lips are closed in both, but tighter in anger as well as more glaring eyes.
- The brows are pulled down in both, but anger has them drawn together.
- All the action of disgust is in the center line of the face
- The lips are open in these two, but the eyes glare more in anger, the upper lip is raised more in disgust than on the left.

Fear and Surprise:

- These are often confused. The eye brows are raised in both, but they are also straightened in fear, not curved as they are in surprised. The upper lid is raised in both, but more so in fear. The lips are parted in both, but more relaxed in surprised, while in fear the lips are stretched back horizontally.

Contempt:

- Contempt is the only unilateral facial expression where all the action is on one side of the face.

Happy:

- Happiness is the easiest expression to recognize, even when it is slight.
- The lip corners are pulled up, but nothing else is occurring to make the expression.
- The intensity and sign of true enjoyment can be seen by a slight lowering of the skin between the eye brow and the upper eye lid.

Sadness:

- In sadness, the inner corners of the eye brows are raised in the center of the forehead. The upper eye lid often droops and the lip corners are pulled down slightly.